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RETINAL INSENSIBILITY TO ULTRA-VIOLET AND INFRA-RED RAYS.

BY L. WEBSTER FOX, M. D., AND GEO. M. GOULD, A. B.

We have received from numerous friends and correspondents many queries concerning the questions discussed in our articles in the July and September numbers of this journal, and they are nearly all connected with an indistinctness or entire misapprehension of the real character and extent of the relative energies of different parts of the spectrum; there appears to be a want of clearness as to the essential nature of the retinal stimulus, and this indefiniteness seems to sum itself up in the question, "Why does the retina fail to respond to the ultra-violet and the infra-red ethereal vibrations?" To avoid the labor of repeating much the same answer to many, we beg the reader to excuse the intrusion of another communication in which we desire to give a *résumé* of relevant facts, and such hints of explanation as with the existing state of science seem possible.

LIMITS OF ETHEREAL WAVE-LENGTHS THAT HAVE BEEN STUDIED.

A glance at FIG. 1[1] shows the measurements of the waves that

[1] The illustrative cuts accompanying this article are printed from plates kindly loaned us by Prof. Langley and the proprietors of the *American Journal of Science*. Our indebtedness to Prof. Langley and his most valuable researches is too evident to require notice. But our own gratitude to that eminent scientist is only a small fraction of that given him by science-lovers in general and light-students in particular.

have been studied. The figures 1, 2, 3, etc., give the wave-length in *microns*, (μ), or one-hundred thousandths of a millimetre; the heights of the curved lines give the relative values in heat units, or the relative absolute energies of the different spectra compared. The visible and invisible solar spectrum is the first to the left and extends from wave-lengths of a size of about one-third of a micron to those nearly three in length. The other curves represent the vibrations proceeding from terrestrial bodies heated to the degrees indicated. The first and most interesting fact that appears from this extremely condensed representation is the discovery it shows of the extension of our knowledge of wave-lengths into regions hitherto unknown. We now have knowledge of undulations eight times the lengths known to Newton; and this is due entirely to Prof. Langley and his marvelous bolometer, by whose aid he measures a degree of disturbance less than the $\frac{1}{10000000000}$ part, a delicacy of estimation so utterly beyond comprehension as to seem fabulous. The approximate estimate of minimum value assignable to the longest wave recognized by the bolometer in any heat from a rock-salt prism is given as 0.030 (units of a mm.) whilst the length of the shortest sound-wave corresponding to the highest musical note perceptible by the human ear (about 48,000 vibrations per second) is 14.0. So that, though the gulf between the shortest ærial undulation and the longest known ethereal is still a wide one, it is far less than before, and practically inconsiderable and uninteresting, except to the student of physical geography.

The smallest waves that have been measured are the extreme rays from aluminum in the induction spark, estimated at 0,185 μ. Of the solar radiations, the shortest that penetrates our atmosphere is 0.29 μ. The shortest visible to the naked eye is 0.35 μ, though by the aid of the fluorescent eye-piece of Soret, by photography and quartz trains, vision has of late been greatly extended. The longest waves to which the retina responds are about 0.81 μ, and the longest solar vibrations that penetrate our atmosphere are 2.7 μ. Thus we see that the range of vision (from .35 μ to .81 μ) is a little over one octave. All this is roughly shown in the figure (I) referred to. Let us now spread the solar spectrum out so to study it more exactly. This is done in FIG. II:

is here extended so that we have in about 12 inches a graphic delineation of what was before crushed into one-twelfth the space for purposes of comparison. In this way we get a comparative view of relative values of the visible and invisible spectra. At this point it may be well to throw in a word of explanation as to the unit of measurement used, or of the proper meaning to be attached to the broken curve; it represents the abstract kinetic value or absolute energy contained in the radiations apart from all considerations of the receiving substance. Much of the confusion existing concerning these questions arises from many misleading or positively absurd diagrams in old text-books or articles devoted to the "plebification" of knowledge concerning these matters. It is now agreed that the kinetic value of all ether waves is measurable in terms of heat, and that the greatest energy of the spectrum is in yellow; at high noon it is about wave-length 0.55 μ, whilst about sunset it is near wave-length 0.65 owing to the increased absorption of the shorter waves by the greater thickness of the atmospheric layer. The difference of effect produced by an impinging series of ether-waves arises solely from the merely accidental nature of the receiving medium. The energy of the ultra-violet rays is so small as to be almost infinitesimal, but because these rays happen to correspond in beat to the vibrational frequency of the molecules of the haloid salts of silver,and the highly imporportant consequences resulting therefrom in the art of photography, their importance in an absolute or in a visual sense has been greatly overestimated. It is a startling fact that a photograph can be taken by the aid of these vibrations in a room absolutely black and without light to a normal eye. It has been a popular fashion tocall these rays actinic, and the infra-red, "heat" waves; those be-tween, "light" waves. But every ray whatsoever is a heat ray, and the rays producing the greatest heat are precisely those producing, when falling upon the retina, the greatest visual effect. The energy-cure, the heat-curve,and the light-curve are in great part identical, and the apex of this curve is about wave-length 0.55,great as shown in the diagram. Thus a nomen-

clature that does not presuppose any theories, or unconsciously mislead the mind, is to call these three divisions by the simple names, ultra-violet, light, and infra-red.

Relative Energies of the Three Divisions.

The kinetic value of the ultra-violet rays is for our purpose too insignificant to consider. It is estimated to be not $\frac{1}{100}$ that of the infra-red rays. The enormous importance of these last has been unnoticed because of the great compression of these rays by the prism, and the inability hitherto of scientists to measure their values. At the present time, however, this portion of the sun's rays is estimated to include nearly $\frac{3}{5}$ of the total energy of the solar radiation penetrating our atmosphere. The exact figures are given as follows:

Luminous and ultra-violet energy, -	0.368.
Infra-red energy, - - - - -	0.632.
	1.000

The Influence of Atmospheric Absorption.

This is a highly important point, and needs careful consideration. In a word, the breaks and sudden dips of the energy-curve shown in the figure are due to the varying powers of absorption exercised by the solar or telluric atmospheres upon the rays in their passage through them. Speaking generally, the absorption increases with the decrease of the wave-length, viewing the spectrum as a whole, though there are local regions of exceptional absorption. The extent of the atmosphere's absorbent power upon the infra-red rays is strikingly shown in the jagged peaks and chasms of the line all the way from Fraunhofer line A., near the limit of visibility, to the end of the solar spectrum. Considering the visible spectrum only, it is found that in penetrating our atmosphere the light rays suffer a relatively larger loss than the infra-red. The atmosphere is also a better transmitter for the light-rays in the winter-season. The general effect of this atmospheric function is to move the maximum energy-point of the spectrum toward the red-end, so that our atmosphere plays the part of an orange or reddish glass. The larger particles of the great dust- and vapor-shell surround-

ing our globe produce a *general* absorption, rendering the whole spectrum less bright and less hot; with infinite degrees this manner of absorption passes into what may more specifically be called molecular, producing the dark telluric lines of the spectrun. The number of these lines increases rapidly from noon till at sunset the spectrum is crowded with them. In ascending a mountain many of the telluric lines fade out even from the spectrum of high-noon at sea-level. We get nearly as much light from the sky on an average as from the sun direct, and the total value of this absorbent power of the atmosphere is concluded by Prof. Langley to be as high as 40 per cent., double the estimate of all previous investigators. If, then, we could, with our eye as at present constructed, rise above our atmosphere, the sun would appear distinctly blueish, because the maximum energy-point of the spectrum would at this elevation be in the (at present) green part of the spectrum, our white light being a compound of only a part of the visible solar-rays, many of the longer ones having been quenched by the atmosphere acting like ever-present reddish semi-transparent spectacles. Fig. III gives a representation of the energy or heat curves of the visible spectrum, 1, outside our atmosphere; 2, within the same at noon, and 3, just before sunset. The apex of the curve is seen to be farther toward A. with each increase of atmospheric depth. Beyond our atmosphere it is at about wave-length 0.50 μ, whilst at noon and evening at sea-level, it is, as we have seen, at about 0.55 and 0.65 respectively. It should be borne in mind that though the light rays suffer a far larger relative absorption than the infra-red, the apex of the curve nevertheless remains comparatively unfissured and is always elevated far above any of the peaks of the infra-red rays.

The Exclusion from Visual Participation of the Ultra-Violet and Infra-Red Rays

seems natural from a glance at either of these diagrams, but especially so from the first and second. In a sentence, it is because the eye has learned to react to the strongest and most constant stimulus or classes of stimuli, and has learned to extinguish or exclude those vibrations that would only confuse by

their weakness or inconstancy. Consideration of the difficulty of focalizing rays of wide differences of refrangibility must also not be forgotten. Were the extremes not shut out, chromatic aberration would certainly be more of a disturbance than at present; and, that the "difficulty" is real is also shown *e. g.*, by the fact of presbyopia. The inelasticity of the lens is complete before old age is reached. First, as to the ultra-violet, the insignificance of the total energy of these rays is perceived by noticing the tiny curve and extent of activity of these undulations figured in the little triangle beyond H. of Fig. II. Not only is the energy too inconsiderable to produce sufficient organic reaction of the ocular mechanism, as compared with the adjacent red space, but the varying quantities of such rays, resulting from the ever-changing remnants left over after the absorptions of the atmosphere have been satisfied, renders constancy of stimulus impossible, and the eye naturally fails to develop response to stimuli, or excludes them from the retina, because they are so weak and capricious. We must, moreover, not fail to recollect the exaggerated importance and mistaken supposition of extent of the rays of this part of the spectrum, naturally engendered by their influence in photography. A line must be drawn somewhere by nature, and the remarkable fact seems to be that the violet rays should not have been excluded from color-production. The limitation of the chromatic scale should not be a cause of critical complaint, but its extension is rather a source of delighted wonder.

In considering

The Infra-Red Rays,

so rich in the total amount of energy and so magnificent in the extent of their wave-lengths, it would at first blush appear that the preceding considerations could have no force or application; but this is a mistake. We think exactly the same reasons sufficient to account for their non-participation in vision. Observe first, that though three-fifths of the total energy of the spectrum is in this region, it is spread over a space six times as great. Now it is apparent that amplitude of range beyond a certain necessary and satisfactory amount, would be of no advantage. How

ever great a spendthrift nature may seem in certain directions, she is still a more niggard economist in others. Extension of the visual function to these regions would imply immense complication of ocular and cerebral mechanism, a complication and intricacy that if in any way possible, would hardly give any considerable advantage to its possessor.

In the next place we must note that this great stretch is one continuous succession of peaks and valleys, or in other words, that its energies are not constant and regular. Cool places alternate with hot ones, and though the shorter wave infra-red peaks are as high as some parts of the visible curve upon the other side, they are not regularly so, and during a fall of the general supply of the radiant energy, as in an obscure day, or in the morning or evening, these valleys would drop down to a level where their maximum of energy would be very small or even *nil.* And this matter of a continual pulsation of the general amount of the stimulus must be borne in mind. It is not a sufficient argument to say that the great space from 0.80 to 0.90 contains an energy as high as that between 0.40 and 0.50. Upon this last side of the curve there is no valley at all, whilst just within A we have a tremendous one that with diminished general illumination would make a break, sharp and decisive, between the two visible portions. *Natura non facit saltum.* Nature is no giant such as Cruikshank and his fairy story picture, striding from mountain-top to top at one step. The existence of this deep and cañon-like chasm at A seems to us highly suggestive. At this point nature seems to have called a halt, and set up there the boundary line of visibility. This gap seems to have served as a legitimate excuse to set bounds to the hungry cry of the organism for greater pre-emption and extension.

Had this cool notch not have existed, it is easily conceivable that the retina might have learned to react to the stimulus extending so far as wave-length 0.95, or even to the next great cool space at 1.15, had there likewise been no such fall as is seen at 0.95. But the great ebb and flow of radiant energy every twenty-four hours, complicated always, and rendered more highly inconstant by the varying conditions of atmospheric cloud and dust, of shade, of vegetation or hill, of longitude and equi-

nox—all these sources of variation and inconstancy served to showthe hard tasked ocular and psychic mechanician that he could only rely with confidence on that part of the spectum, upon those wave-lengths that, under all conditions, were strongest and most persistent. His creatures had to gain the best intimations possible of external objects during foggy and cloudy days, in twilight, moonlight, nay, even by starlight, and at these times the reduction or even extinction of energy in the infra-red regions would be too great or too common to give such indications. Hence the necessity of ignoring them.

We spoke in metaphor of the task of the creation of the retinal and cerebral response being a difficult one. No anthropological or teleological *arriere-pensée* was in our mind. We are as shy of that sort of thing now-a-days, as our fathers were fond of it. What was meant was simply this: None but they who have deeply studied and pondered the delicacy of the force of these ethereal stimuli, have any but the most absurdly inadequate conception of their almost infinitesimal littleness. Prof. Rowland has ruled 160,000 lines to the inch in his concave gratings. The finest slit admitting a beam of light to this grating is one-fifth of a millimetre wide, yet this covers more than the distance between the two D lines, and in this space there are at least a dozen alternations between brightness and extinction. The astounding sensitiveness of the bolometer is far from discerning the absolutely homogeneous ray. Now it has been shown (by *Nichols, Amer. Jour. Sci.*, Oct., '84.) that the retina responds to an exposure to rays, (from the pigments of a Maxwell-disk) lasting only 0.00144 of a second. This was the time for yellow, and at the brightest of three degrees of illumination. For red the figures were 0.00209, for violet, 0.00286. Experiments with spectra of the solar radiation are still more remarkable. B. O. Pierce, Jr., (*Am. Jour. Sci.*, '83) found that the largest displacement needed by any observer corresponded to a difference in wave-length of about 0.000005 *mm.*, the smallest to a wave-length of about 0.0000005 *mm.* In all these cases, the extreme refinement of response is in yellow—precisely where the stimulus is strongest, most invariable and persistent. But what we wish particularly to emphasize is that the most trained imagination

can get only the most impotent and inadequate fancies and glimpses of the marvelous sensitiveness of the retinal mechanism that can react to stimuli represented by the figures above given. Was it therefore not in reality a great feat of the organic mechanic, which, as dethroned Deity we familiarly call Nature, Life, Natural Selection, (we still compliment with capitals—how long will that last?) to develop retinal response, infallibly, swiftly, to such inconceivably fine stimuli? Nothing else in all the domain of the senses can be remotely compared with it, and only because, upon the quick perception of the half hidden gleam of approaching teeth, of concealed enemies, of disguised poisons and fruits—only because, upon the lightning-like recognition of a thousand such subtle and ever varying indications, depended the safety and hourly existence of his creatures in air, earth or ocean, only by and under such prime necessities, could the inconceivable labor have been accomplished! One of our correspondents is puzzled to understand why the retina does not react to the ultra-violet and infra-red waves, the same as carbon and all ordinary absorbers. The question implies a strange analogy and a fatal forgetfulness of the object of vision, the organic needs to which the eye ministers, and the organic means by which this functional activity has been developed. The action of any organic tissue whatever, is only the outcome and epitome of its history. Chemical and mechanical forces have, in this sense, no history; their reactions are always and ever the same; but the moment we have to do with that mysterious somewhat we call life, at least in any but its very lowest manifestations, that moment we can predict the methods and laws of its activity only by a knowledge of the history of the organs through and by which it presents itself to us. Throw light upon the sensitive plate of the photographer, and the silver salts at once go through their paces utterly regardless of the past history of that light, whence it came, how generated, etc. But light thrown on the retina of an ant and upon the retina of a man is perceived as a wholly different sort of stimulus, as Sir John Lubbock has shown, and light from the pursuing hunter, and the self-same quality of light from the coat of its mate produce quite different results somewhere in the receptive mechanism of the deer. In a word,

as we have elsewhere tried to show, it seems strange that the great laws of evolution and natural selection should be so persistently and successfully used to explain the functions and reactions of other organs, and the visual activity be the last to which these principles are applied. But that delightful class of grubbers who have gone clean daft on materialism, and who would, with sublimely comic impertinence, explain life in terms of mechanics, and analyze a maiden's blush into ($C_{600}H_{960}FeN_{154}S_3O_{177}$ [Hæmoglobin])+O+($C_5H_{13}NO$ ["Neurine"]) =X.,—Q.E.D.!—these philosophers do not, to be sure, need even these paltry helps of historic study, to demonstrate truth, any more than did Punch's Humpty Dumpty, "who sat on the wall, to his nurse proving he never could fall, etc.'

Besides the facts of the weakness and inconstancy of supply of the infra-red rays, and barring also the immense complication and increase of retinal and cerebral machinery it would have necessitated, we may pertinently ask of what advantage to the great kingdom of developing animal-life would it have been if retinal reaction had been extended to the infra-red rays? All existing objects become visible by means of the light rays; any object that would reflect these infra red rays already reflects the rays of the visible spectrum in sufficient strength and variety to give the visual mechanism full advices of the existence and qualities of the object. May it not be consistently supposed that the effect of these infra-red rays, if allowed to produce visual result would simply be productive of confusion? The object of color may generally be said to be to give evidence of the qualities of objects. Extension of the color-scale and response would not only give no possible advantage to its possessor, but it may be certainly said that such extension would assuredly disadvantage its unfortunate owner in the struggle for existence, not only by complicating the retinal machinery, but also by rendering the organism's response more uncertain and less lightning-like in rapidity.

Do the Ultra-violet and Infra-red Vibrations Reach the Retina or Visual Centers?

In this connection the question arises as to the means whereby

the visual mechanism rids itself of the confusion that would naturally follow from the influence of these rays (or the impulses resultant from them) provided these were allowed access to the retina. It has been suggested that the ocular media may act as a strainer, or filter to these wave-lengths, quenching or absorbing their energies so that they do not in fact reach the retina. So far as we know the only definite answer to this question pertains alone to the ultra-violet undulations. A French scientist, M. de Chardonnet (*Comptes Rendus, Tome* 96, p. 144) utilized the power that these rays have to produce chemical changes in the sensitive plates of the photographer, to test the relative transparency of the different ocular media of man and the vertebrates to these rays. The crystalline, cornea and vitreous were tested separately. It was found that the adult crystalline of man quenched the spectral waves between Fraunhofer lines L and M. It required a long exposure of the plate to produce response therein by waves the length of those of line M. The vitreous was transparent to the rays between S and *s*, the cornea permitted weak traces to T. One or another of the media in animals was opaque to rays beyond L or M in the ox and frog, N or O in the fish, P in the cat, R in the calf, sheep and hog, S in the turkey and owl, T or U in the hawk. No eye whatsoever was found transparent to the ultra-solar rays[1], or to those shorter than T or U. So far then, as relates to the human eye, it was found that the vitreous and cornea were transparent to a much greater extent of the ultra-violet rays than the crystalline, and the problem narrowed itself to experiments upon living aphakial eyes. On p. 509 of the same volume of the *Comptes* M. de Chardonnet reports as the results of his experiments upon such eyes that he found the living normal retina sensitive to ultra-violet waves almost to S. Beyond this, of course, it was impossible to test because the cornea and vitreous became opaque at this point. It is of interest to note that the individuals thus experimented upon testified the suggestive fact that

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1 That is, to those waves of the electric light which are shorter than any penetrating our atmosphere from the sun.

their impression as to the color of the ultra-violet rays was that it was of a light blue or a delicate grayish blue hue. A word of explanation also as to why people without the crystalline lens do not complain of the bluish tint of objects[1]. Leaving out of consideration the fact that what habitually colors or changes the proportions or averages of rays so slightly as this, would, from mere habit, drop out of conscious recognition, it may be remarked that the excessive weakness and relatively small amount of the ultra-violet solar radiation reaching the eye would not, except perhaps to the sensitive retina directly after cataract operation, materially change the general tint of a multitudinously compound mass of rays such as naturally enters the eye at any one instant. But far more conclusive is the fact that *without* spectacles there is no emmetropic focalization of rays on the retina, only a multitude of diffusion circles; whilst *with* spectacles (which of course are commonly worn) these ultra-violet rays are absorbed by the glass and never even reach the cornea. Parenthetically, it may be noted that to this circumstance—the opacity of glass to the greater part of the ultra-violet radiation—is probably due our immunity from fatigue and from what would be a novel form of asthenopia or ocular disease arising from the electric light: the incandescent lamp being surrounded by a film of glass quenches those rays that in this light are very numerous and (comparatively) powerful. If this severe and unusual task were thrown upon the crystalline, it is reasonable to suppose a disturbance of its function might probably result.

Referring again to the straining function of the human crystalline, M. J. L. Soret (*Comptes. Tome* 97, pp. 314 and 572) finds that its absorbent power is not, as first supposed, due to the albuminous substance, globuline, forming the mass of the lens, but that it is effected by means of a crystalline substance secreted by the lens. Now, is there not in this fact evidence of a suggestive and convincing kind, since, as we have seen, the ocular media in the lower animals are generally transparent to

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1 We may remark that we have had patients just operated upon for removal of the lens exclaim that the objects first seen appeared distinctly bluish in tint.

much shorter waves than in man, that it has been found in the developement of the higher vertebrates, and especially in man, that the admission of the ultra-violet rays to the visual function has been undesirable and their participation in this way (and as it were purposively) guarded against? As the calf's eye was found transparent to shorter waves than that of the grown animal, so it may be predicted that the babe's eye will be found to permit the passage of shorter rays than the adult human eye.

The reason that different normal eyes are variously sensitive to the waves in the neighborhood of the ultra-violet demarcation-line is thought to lie in the varying degree of fluorescence possessed by different crystalline lenses. The normal crystalline is fluorescent to about the same degree as quinine, or in the higher animals to near Fraunhofer line O, or R.

Whether or not the visual mechanism of such animals as the hawk, turkey, etc., really react to the extremely refrangible rays allowed to pass by their ocular media, it was impossible to learn, owing to the evident reason that the human eye could not see in that "darkness" if motion followed the stimulus or not.

Turning at last to the far more important infra-red rays, we find only analogy and speculation to aid us. We know of no such experiments with these as with those we have just discussed. Here, indeed, photography can be of no aid, and only a thermometer so delicate as Prof. Langley's bolometer could give any result claiming correctness, by passing such rays through the living or but lately living eye, thus testing whether they were intercepted or not, and where was the line of demarcation. This has not to our knowledge been done. But a multitude of objections at once arise. To do this with the living eye is quite beyond possibility, at least with a normally living one, and the coexistence of pathological condition might justly be held to vitiate any result obtained. The objection would gather force as regards experiment upon dead tissues, and the experiments of M. Chardonnet are in this respect open to not a little criticism. The living eye might have a function or be without a function as a wave-filter, that would make the results of experiments upon the dead eye of a highly doubtful character. Moreover, the ocular

media as such may be proved not to have this filtering action, and criticism is not checkmated by many moves; the layer of axis cylinders, highly complex and organized structures, of which there are some 800,000 spread out over the concave surface of the globe, may exercise an absorbent or modifying agency; not only does the entering light have to pass through these structures (except at the fovea) but it has also to pierce the still more highly organized and extensive eight or nine distinctly recognized strata of the retina before reaching the tips of the rods and cones or the pigmentary substance into which these extend. It seems wholly beyond the possibility of experiment to determine whether these may not, when instinct with quivering life, exercise an influence upon the transmitted rays. The inexplicable and apparently unnatural arrangement whereby the points of the retinal end organs are turned away from instead of toward the entering stimulus may not be disconnected from this interesting question. It must certainly have been another great task to make so complex an organizism as the retina so wonderfully transparent. Its transparency, however, may only be to the light rays, and it may possibly be wholly opaque to the infra-red. If it were proved that the rays in question do reach the pigment masses about the cone tips, it would conform to the theory of heat as the retinal intermediate that we have previously set forth, to suppose no receptive substance were there secreted whose vibratory phases corresponded to those of the infra-red rays. Lastly, it may not be held improbable that there is retinal response to these stimuli but no neural transmission to the brain; or, supposing there be such reports sent up, that, even as a final resort, the brain refuses to notice intimations that, from their inconstant, weak, or confusing character, are more wisely ignored. A thousand facts of experimental psychology show the cerebral co-ordinating centre to have such powers and to habitually exercise them.

The Retinal Stimulus of the Lower Animals.

An interesting question here presents itself, and may be alluded to in passing: Does the visual mechanism of other orders of animal life differently situated from ourselves respond to other

wave lengths than our own? It is beyond question that every body whether solid, liquid, or gasseous, whether what we call "hot", as the sun or a red-hot stove, or whether what we call cold, as ice, is a continuous source of that radiant disturbance to the ether about its particles we call ethereal undulations; therefore the ether is vibrating at all rapidities from those already studied to those much slower, and probably down to those rapidities that may equal those of air. We have seen that the knowledge of a vast extent of these rapidities has lately been gained, almost bridging the space. Do eyes exist sensitive to the infra-red rays? Lubbock has shown that bees, ants, etc., respond to waves of the visible spectrum in a general way, as we do, but with some notable exceptions, especially in the more refrangible parts of the spectrum. That the vast majority of the higher animals whose life struggle has been under much the same circumstances of light and shade as ourselves, possess essentially the same visual response as we do, is reasonably certain. But it may be logically supposed that such animals as have been wholly differently situated may have developed reactions to the longer waves we have found most economical to ignore. But little study of the eyes of such low orders as the *Coleoptera*, *Annelida*, etc., has been done, but that little renders it highly probable that they have a receptive mechanism for vibrations between the upper limit of aur auditory frequency and below that of our light perception. The study of the eyes of nocturnal insects, of the inhabitants of the sea at different depths, of electrical and phosphorescent animals, etc., may prove highiy instructive in this respect.

Again returning to the human eye and to our subject, we may ask what reason would there be for the extension of retinal reaction to the longer ethereal vibrations when the possibilities of color are infinitely far from being exhausted within the limits of the visible spectrum? The average visual sense commonly perceives as one and the same color, waves differing in their frequencies of arrival by such stupendous numbers as millions of millions in a second of time, as was pointed out in a previous article: Instead of straining its energies to develop response to those weak and capri-

cious stimuli, the infra-red rays, nature were more wise to expend its energies in differentiating the possible color differences at its own door, and within the already accepted limits. Without seeking out the distant heathen, this missionary spirit could be wisely spent in the conversion of the crowds in its own neighborhood and native land. And this is precisely what nature seeks to do. The Roman mosaic workers are said to have used 30,000 different tints; 28,000 shades of wool are used at the Gobelins manufactory, and speculation has run riot in attempting to calculate the numbers of the perceptions of color-differences possible to the cultivated eye. Exercise, as we know, develops delicacy of color perception, the Quakers being deficient in this respect, whilst the trained eye can easily detect differences of hue that another cannot perceive at all. A common and superficial remark has been that the eye with its response to but one octave of the color-scale is so much poorer than the ear that reacts to many octaves of the sound-waves. The truth is that if the possibilities of hearing were multiplied a thousand or a million fold, they would not begin to rival the infinite complexity and inconceivable opulence of varied result existent and possible with the single octave of the visual stimulus. Both the human eye and the bolometer are so far from reporting the absolutely homogeneous wave-length that the distances and numbers are utterly beyond the mind's powers of appreciation. The range of hearing practically extends from wave-rapidities of about 40 to those of about 4,000 per second, and trained musicians are said to be able to detect a difference of $\frac{1}{6}$ of a semitone in the middle registers, so that the addition of a single vibration per second becomes recognizable to a highly-cultivated ear. It would therefore appear that the refinement of auditory sensibility had reached, if not its limits, at least that degree of exquisiteness reasonably desirable. But turning to ethereal vibrations we find that the eye perceives no difference in the tint of two bands of color caused by wave-systems differing in their rapidities by numbers beyond mental comprehension. The lengths of ærial undulations vary from $\frac{1}{5}$ of an inch to 33 yards; those of ethereal vibrations (visible spectrum) from .29 to .81 one hundred thousandths of a millimetre; but the delicacy of actual and possible visual sensation is propor-

tionately multiplied with this descent into the infinitely minute, so that progressive extension and refinement of the color-sense even within the octave, stretches out illimitably. Therefore in yet another sense this divine endowment of vision that seems to be *par excellence* the intermediary between the objective world of infinitely extended matter and space, and that other world of mind as wholly infinite in its way, binds us also to a third infinity, time, in the progressive education and spiritualization of the limitless color-sense which we see is possible in Humanity's onward march. The truest and tritest of truisms is that of our utter inability to conceive what human or animal existence would have been without the sense of vision. We could not have gained the intellectual eminence of a mole or the blind-fish of the Mammoth Cave because these are products, however degenerate, of ages of vision-endowed ancestry. Even the grasshoppers of the Mammoth Cave have lost their wings. Intellect surely became possible only through and by vision; and all the objects and products of our intellectual activity are indissolubly bound up with the results and processes of ocular activity. But what finally underlies and renders possible all this sublime extension and developement of the higher life? Simply this all-penetrating, all-surrounding somewhat, that we can only adequately think of as the spirit or as the spiritualization of matter, that we can only describe by using nearly all the old terms which theology and philosophy have heretofore jealously reserved as the exclusive attributes of the deity. The ether is certainly in a strictly legitimate sense a creator of us, since man, as man, could not have developed without vision of the external universe, and vision is the common product of life and ethereal energies. The microcosm exists because the macrocosm sublimed its essences to a quivering impalpable spirit of a sufficiently high tenuity, delicacy and expansiveness, to interpenetrate and enfold all material particles, and stretch to the confines of creation. No scientist or philosopher sees the faintest hint on purely material grounds of its *raison d'etre.* Its genesis is the blankest of mysteries. It seems a somewhat, and yet utterly distinct from what we commonly call matter. It appears to be of a completely distinct and different category of be-

ing from gravitation, neither giving nor asking of it service; suns and worlds could have wheeled on their courses without it, and life of an eyeless, non-intellectual, non-spiritual and sluggish variety might perhaps have arisen where it was not. As blinded bats by means of their interdigital extension of sensitive cutaneou ssurface, avoid obstacles in flying by a fine perception of the greater barometric pressure near such objects, so man, developing without light, might be mentally pictured as at the best a sort of huge diabolic pterodactyl-like bat flapping his way through the cimmerian landscape! (The picture may stand for the edification of a stray critic or two who has kindly and vaguely hinted that we were over-interested in our ether-waves. *Sua cuique voluptas!*)

But, seriously once more, if we consider the facts that electricity and magnetism (which are its stresses) would not have been our daily aids and delights, that life on all but self-heated worlds would have been impossible without the heat-transferring agency of the ether, that all vegetation is its creation, and animal life is to us almost inconceivable without vegetation—when we think of these physical facts the rapture and adoration of sun- and light- worshipping religions and peoples becomes reasonable. These and other reasons, we think justify our studies of ethereal activity which many doubtless have thought needlessly ly long and labored. But to any one whose mind is not content to live incurious of the many mysteries among which we vulgarly swim, this superlative mystery of light and the laws of ethereal activity offers the most brilliant and absorbing, and at the same time satisfying of all fields of study. But it is when we think how the mind of man only came into being by its aid; how almost all reasoning, *i. e.*, operations of the intellect, are by means of the metaphors and pictures of light and color; and lastly how the Beautiful, that smile of God which we may also call the splendor of truth and the sign-manual of the world's divine architect and owner, is solely by means of its undulations. —it is only when we ponder upon these things that we are lost in wonder, and recognize that if anywhere in the doubtful maze of cosmic circumstance purposive and supernatural agencies become visible, it is in the creation of that subtle mystery and, for the existence of intelligent and spiritual beings, transcendently important and necessary essence, we call the ether.

ON THE OPERATIVE TREATMENT OF ENTROPIUM.

BY JOHN GREEN, M. D., ST. LOUIS.

Continued from Vol. I, Page 266.

It has fallen to the lot of the writer, in the course of twenty years of practice in St. Louis, to have to do with a very large number of cases of entropium, many of them aggravated by long neglect, or complicated by ill-devised or badly executed attempts at cure. In by far the greater number of cases the entropium has been a sequel of trachoma, which has either run its full course, with resultant cicatrization of the conjunctiva and more or less conspicuous incurvation of the tarsus, or has continued in some degree active in consequence of repeated exacerbations due to persistent or renewed irritation. Very often the incurvation of the tarsus has been complicated by persistent spasm, sometimes with apparent hypertrophy, of the orbicularis muscle, which has then played an important part in maintaining and increasing the inversion of the lid-margin. In but a single instance has a typical spasmodic entropium, with complete rolling inward of the tarsal margin, been observed in the upper eyelid; in all other cases the purely muscular type of the affection has been limited to the lower lid. So far as it has been possible to trace their beginnings, the cases of spasmodic entropium have all originated in some form of conjunctival or corneal irritation, varying in intensity and in duration from that occasioned by the lodgment of a foreign body in the conjunctival sack, or by a minute corneal phlyctenula, to the chronic irritation and blepharospasm incident to active trachoma complicated by corneal ulceration and pannus. The senile entropium of systematic writers has also been not infrequently observed, but it has been impossible to recognize in it anything more than a variety of spasmodic entropium, excited by some degree of conjunctival or corneal irritation, and favored by the abnormal laxity of tissue incident to senile emaciation.

In nearly all the cases observed, there had already been some attempt at treatment, and oftenest by frequently repeated partial or total epilation of the lid-margins. Next in frequency were cases in which a large piece of the skin, or of skin and muscle, had been excised from the upper or lower eyelid, or from both lids, with closure of the wound by sutures, often of coarse thread and deeply placed, which had not infrequently been left to cut their way out by ulceration and had given rise to permanent and sometimes highly disfiguring scars. In rarer instances, an attempt had evidently been made to supplement the excision of a portion of the lid-integument by splitting the lid-margin, as taught by Arlt, but almost always with the result of leaving a group, or even a considerable row of deviated cilia which the patients had afterwards continued to pull out for themselves or to have pulled out for them by friends. In other cases a smaller or larger number of cilia had been destroyed by some form of cautery applied to their follicles, but with the ultimate effect, in every case observed, of drawing some of the neighboring cilia out of line, to rub upon the eyeball in place of those which had been more or less perfectly destroyed. In still other cases, large and deep sutures had been inserted and tightly knotted, so as to constrict and cut through the cutaneous and muscular layers of the lid, thus giving rise to unsightly vertical bridles of cicatricial tissue, although generally without accomplishing the desired end of correcting the inversion of the lid-margin. Most distressing of all were certain cases, even now occasionally met with, in which great contraction of the palpebral fissure, together with inability perfectly to close the eyes, has followed the free abscision of the lid-margins in their entire thickness; a lamentable condition, which nevertheless was accepted in certain cases by Heister, as *miserum sed unicum auxilium*[1].

In my earlier operations on the upper eyelid, I followed, almost exclusively, the method of Arlt, as I had learned it, in 1860, in Vienna.[2] In such cases as were seriously complicated by

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1 Heister—*Institutiones Chirurgicæ*, Amstelodami, 1739. Pars II, Sect. II, Cap. XLVI, III.

2 *Vid.* Arlt—*Die Krankheiten des Auges*, Prag, 1850.

blepharospasm, or by organic contraction of the palpebral fissure, the operation was either preceded by or combined with a free division of the outer canthus and union of the cutaneous and conjunctival margins of the cut by sutures.[1] If the trachomatous process was still active, the performance of Arlt's operation was deferred until this condition had been corrected, as far as possible, by appropriate treatment, and in cases in which the lid-margin had been previously epilated, advantage was taken of this delay to allow the cilia to grow again. If, as was not infrequently the case, a considerable portion of the lid-integument had been already sacrificed, I abstained from further mutilation in this direction, contenting myself with a free dissection between the orbicularis muscle and the front of the tarsal tissue, and holding the thoroughly loosened flap well up toward the eyebrow, by means of sutures or collodion, until it had become adherent in its new position. In the more regular Arlt-operations, a few cases of partial destruction of the marginal bridge of cilia-bearing tissue taught me to abstain from completely detaching this bridge, especially in its middle third, and, finally, to leave it connected with the eyelid, in its entire length, through the undivided orbicularis muscle, as Arlt also has latterly advised.[2] In the beginning, I followed Arlt and the ancient writers closely in excising a pretty large crescent-shaped piece of integument, but after I had proved the advantage of preserving the continuity of the marginal tissues with the standing portion of the eyelid, I ventured to make the excision along a line much nearer than before to the row of cilia, in which position I found it quite sufficient to remove only a narrow strip not exceeding two or at most three millimetres in width. In other cases I dispensed altogether with the excision of even a narrow strip of skin, and, after dissecting freely between muscle and tarsus, rolled the margin of the cilia-bearing flap forward, and at the same time held it well up towards the eyebrow, by means of three or more deep sutures entered in the marginal incision substantially as

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1 Ware—*Chirurgical Observations Relative to the Eye*, 2nd Ed., London, 1805, Vol. 1, p. 96.

2 Graefe-Sæmisch. *Handbuch der gesammten Augenheilkunde*, III, 450.

has been since advised by DeWecker[1]. v. Graefe's modification of Arlt's operation[2] was aiso tried, but with the result of abandoning it as offering no appreciable advantage over the original method when executed strictly in accordance with Arlt's description.

In all these operations the most important feature of Arlt's method, namely, the splitting of the eyelid by an incision made just in front of the line of the openings of the Meibomian glands, was retained; and such changes as were made in the other parts of the procedure, were prompted by the desire to avoid the risk of ulceration or sloughing of the marginal bridge, and the mutilation incident to the excision of a large piece of skin. These desiderata were fully attained in the modified procedure, and the immediate results were as good as I have ever seen from Arlt's operation, whether as observed in his clinic or in my own practice or that of other surgeons. The final results, as observed after the lapse of a year, or even less, were, however, in the highest degree discouraging, and this not only in the cases in which I had followed Arlt most closely, but also in those in which I had adopted one or another of the modifications just mentioned.[3]

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1 DeWecker—*Chirurgie Oculaire* Paris, 1879.

2 *Archiv f. Ophthalmologie*, X, II, 1864.

3 The operation of Arlt, when skilfully executed in strict accordance with the directions given by its author, yields a large proportion of cures, which, however, fall far short, so far as I have observed, of a perfect *restitutio ad integrum* of the lid-margin. In many cases, the direction of the deviated cilia is so far improved as to remove them permanently from a position of actual contact with the eyeball, but an ideal restoration of a perfect row of permanently well-directed eyelashes is, so far as I have seen, the rare exception. Besides this shortcoming, the error is very often committed of attempting to increase the effect of the operation by excising too large a portion of the lid-integument, thus giving rise to very positive disfigurement through the partial or even total effacement of the tarso-orbital fold. The perfect execution of the marginal incision, so as to include all the cilia with their bulbs in the anterior flap, is, moreover, a somewhat difficult matter, and any error in this respect involves the practical failure of the operation.

Recent modifications of Arlt's operation, in which a narrow strip of integument, attached at both ends, is transplanted from the front of the eyelid to fill the gap made by splitting the lid-margin, or in which a strip of buccal mucous membrane is transferred to the same position, are doubtless of value as opposing the tendency to secondary reproduction of the trichiasis; but they make the operation quite complicated, and leave the incurvation of the tarsus uncorrected.

Disheartened by the generally imperfect results obtained from Arlt's operation, I next tried the procedure of grooving the front of the tarsal tissue, as taught by Streatfeild,[1] and adopted, with certain additions, by Snellen.[2] The excision of the narrow wedge-shaped strip from the front of the tarsal tissue was at first found to be attended with no little difficulty, which, however, was in a great measure overcome by making use of a special knife of the form shown in FIG. 22. It not infrequently happened that the conjunctiva was cut through in some places, but this accident was found to be attended by no untoward consequences, and the results attained by the operation were, on the whole, more satisfactory than the best which I had observed in the cases in which I had followed the method of Arlt.

FIG. 22.

My attention was next attracted to a paper by E. Jæsche,[3] describing, with certain modifications, the operation of George Jæsche,[4] upon which Arlt had based his procedure. As described by E. Jæsche, the upper eyelid is first transfixed, from within outward, by means of a double-edged, sharp-pointed knife, one line from its free margin; the cut is then extended, in the temporal and in the nasal direction, by scissors. The entire lid-margin, bearing the cilia and their bulbs, is thus completely severed from the rest of the eyelid, excepting only at its two ends, near the outer and the inner canthus. The integument is next dissected off from the front of the eyelid, up to about two lines below the eyebrow, and the wound closed by three sutures. The needles are entered just in front of the normal cilia, and the ends of the sutures are left long, and are fastened by adhesive plaster to the forehead, so as both to raise the detached lid-margin and turn it forward.

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1 *Ophthalmic Hospital Reports*, I, III, April, 1858.

2 *Compte-rendu du Congrès Périodique d'Ophthalmologie*, Paris, 1862.

3 *Klinische Monatsblaetter f. Augenheilkunde*, XI, 1873.

4 *Medicinische Zeitung Russlands*, 1844; quoted by Arlt, in Graefe-Saemisch, *Handbuch*, III, 450.

My experience with this method was reported in a verbal communication to the American Ophthalmological Society at its 10th annual meeting,[1] July, 1874, in which I stated that I had performed the operation about fifteen times, but had modified the procedure in that I had excised only a very narrow strip of skin, and had relied mainly on deeply-placed sutures to turn the lid-margin forward and to retain it in its corrected position during the first twenty-four or forty-eight hours. The results obtained from this operation were, as a rule, most encouraging, but with the serious drawback that in two or three instances the central portion of the marginal bridge had, in some measure, lost its vitality, and thus a part of the row of cilia had been but imperfectly preserved. The resultant disfigurement was, however, much less than after the occurrence of the same accident in cases in which I had excised a broad piece of integument,as in Arlt's operation.

To obviate this danger, and, at the same time, to retain all the special advantages of Jæsche's operation, I next modified the procedure by limiting the principal incision to the conjunctiva and tarsal tissue. I was thus enabled to vary the position of the cut in different cases, placing it sometimes within a millimetre of the line of openings of the Meibomian glands, and at other times at twice or three times that distance, as the special conditions seemed to demand. In certain aggravated cases, I found it of advantage to make two parallel incisions in the conjunctiva and tarsus, the one quite near to the line of the openings of the Meibomian glands, and the other further back, at a distance of two millimetres or more from the first.[2] I was also able, without incurring the danger of ulceration or sloughing of the marginal tissues, to excise the narrow strip of skin along a line very near to the row of cilia,[3] as already mentioned in connection with Arlt's operation. In placing the sutures, generally three in number, I entered the needle in the lid-margin, either exactly in the line of the cilia or sometimes a little behind them, and, grazing

1 This communication is noticed in the Transactions for 1874, but is not published, as the Society did not, at that time, print a full report of its verbal proceedings.

2 *cf.* Aetius.

3 *cf.* Celsus, Aetius and Paulus Aegineta.

the front of the tarsus, carried it upward until its point emerged through the skin, a line or two below the eyebrow. (See FIG. 23.) The sutures were then tied, but only with such degree of tension as was necessary to effect the desired eversion of the lid-margin; to insure against suppuration occurring in their tracks, they were left in place not longer than twenty-four, or, at the furthest, forty-eight hours. After the removal of the sutures, I generally applied collodion along the line of union, in order both to support the forming cicatrix and to regulate the eversion of the lid-margin.

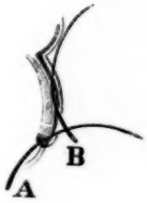

FIG. 23.

Of this improved procedure I published, in 1876, a short description,[1] in which I spoke of it as logically developed from Roser's modification[2] of v. Ammon's *tarsotomia horizontalis*[3]. Its true prototype is, however, to be sought rather in the ordinary procedure of the ancients, as described by Celsus, Aetius and Paulus Aegineta. In the description given by these writers, the essential part of the operation, as performed upon the upper eyelid, is the *ὑποτομή*,[4] a long and deep incision made in the everted lid upon its conjunctival aspect, parallel to and behind the line of the inverted cilia, and probably, as a rule, also behind

1 *Transactions of the Fifth International Ophthalmological Congress*, New York, 1876.

2 *Archiv f. physiologische Heilkunde*, XII, 1853, 511.

3 *Zeitschrift f. die Ophthalmologie*, III, 1833, 247.

4 Translated *subsectio* in the version of Cornaro, Lugduni, 1549.

the openings of the Meibomian glands.[1] The *ὑποτομή* was gen-

[1] The words of Celsus, — *in superiore palpebra sub pilis ipsis incidenda linea est, ut ab inferiore parte diducti pili sursum spectent.* — taken by themselves, may mean that this incision was intended to be made quite near to the line of the inverted cilia, and, therefore, possibly not farther back than the row of openings of the Meibomian glands. Aetius, however, writes more specifically, — *ἐκστρέψαντες τὸ βλέφαρον διδῶμεν τὴν ὑποτομὴν ἔσωθεν τῶν παρὰ φύσιν τριχῶν, ὥστε αὐτὰς πρὸς τὰς κατὰ φύσιν ἔξω νεῦσαι. ἐνίοτε δὲ κατ' αὐτῶν τῶν παρὰ φύσιν τριχῶν.* And again, contrasting these two positions, — *οὐδὲν δὲ κωλύει καὶ δύο ὑποτομὰς διδόναι, μίαν μὲν ἐνδοτέρω τῶν παρὰ φύσιν τριχῶν, ἵνα ἀνάκλασις γένηται τοῦ ταρσοῦ, ἑτέραν δὲ κατ' αὐτῶν τῶν παρὰ φύσιν τριχῶν.* In this description the words *κατ' αὐτῶν τῶν παρὰ φύσιν τριχῶν* may be assumed to refer to a position corresponding approximately to the line of the Meibomian orifices; but, in any case, the two expressions, *ἔσωθεν τῶν παρὰ φύσιν τριχῶν* and *ἐνδοτέρω τῶν παρὰ φύσιν τριχῶν*, contrasted, as they are, with *κατ' αὐτῶν τῶν παρὰ φύσιν τριχῶν*, can only be understood as implying a position considerably farther back from the lid-margin, and, therefore, necessarily at some distance behind the line of the Meibomian openings. The description of Paulus Aegineta, — *ἐκστρέψομεν τὸ ἄνω βλέφαρον, εἰ μὲν μακρὰς ἔχοι τὰς τρίχας, αὐτῶν ἐκείνων τῷ λιχανῷ καὶ μεγάλῳ δακτύλῳ τῆς ἀριστερᾶς ἐπιλαβόμενοι χειρός, εἰ δὲ πάνυ βραχείας, βελόνην ἔχουσαν ῥάμμα διὰ μέσου τοῦ ταρσοῦ ἔσωθεν ἐπὶ τὰ ἔξω διαπείραντες· εἶτα διὰ τοῦ ῥάμματος ἀνατείναντες τῇ ἀριστερᾷ τὸ βλέφαρον, τῇ δεξιᾷ τῷ πυρῆνι τῆς σμίλης ὄπισθεν τοῦ ῥάμματος αὐτὸ κολπώσαντες ἐκστρέψομεν, καὶ δώσομεν τὴν ὑποτομὴν ἐσωτέρω τῶν νυττουσῶν κατὰ τοῦ ταρσοῦ, ἀπὸ τοῦ μεγάλου κανθοῦ διήκουσαν ἄχρι τοῦ μικροῦ. τὸ δὲ ῥάμμα ὑπολαβόντες μετὰ τὴν ὑποτομὴν καὶ τῷ ἀντίχειρι τῆς ἀριστερᾶς χειρὸς ὑποβαλόντες μικρόν τι πτυγμάτων, ἀνατείνομεν τὴν ὀφρῦν*, — taken as a whole, seems also fully to justify the view that the *ὑποτομή* must have been intended to be placed at some distance back from the lid-margin. The passing of a thread (*ῥάμμα στερεόν*, Aetius), *διὰ μέσου τοῦ ταρσοῦ ἔσωθεν ἐπὶ τὰ ἔξω διαπείραντες*, by the aid of which the eyelid is directed to be everted in cases in which the eyelashes are too short to be seized by the index finger and thumb, and the further direction to remove the thread after the *ὑποτομή* has been completed, make it nearly certain that the position of the *ὑποτομή* was intended to be behind this thread; and, inasmuch as the thread could scarcely have been placed nearer to the lid-margin than the line of the Meibomian openings, the *ὑποτομή* must needs have been behind this line.

erally, though not always, supplemented by the excision of a crescent-shaped[1] piece of skin, bounded below by a line parallel to the row of cilia, and above by a curved line, carried up toward the eye-brow, with closure of the wound by sutures.[2]

From this ancient procedure, my own practice, in 1874-75, differed at the widest, (1) in defining the position of the under-incision—*ὑποτομή*—as behind the row of openings of the Meibomian glands, (2) in excising a very narrow strip of skin[3] instead of a broader, cresentic or myrtle-leaf-shaped piece,[4] and (3) in the manner of placing the deep sutures, which I entered in the lid-margin, in or just behind the line of implantation of the cilia, rather than in the lips of the gap in the skin,[5] or in the under-incision itself.[6] The plan of slinging up the loosened lid-margin by plastering the free ends of the sutures to the brow[7], I had already tried and abandoned.

It must not be forgotten that Celsus, comparing this operation with other plans of treatment, — namely, by destroying the bulbs of the cilia by the actual cautery, and by attempting to replace the deviated cilia, one by one, by the method of *illaqueatio — repositio ciliarum — ἀναβροχισμός*, — writes of it as the generally approved and sure method: *ea vero curatio quae palpebrae laxioris ab omnibus frequentatur, nihil habet dubii.* The clearly expressed purpose of the under-incision — *ut ab inferiore parte diducti pili sursum spectent* — is perfectly attained, and the immediately following statement — *idque, si levis inclinatio est, etiam solum satis tuetur* — is fully realized only when this incision is made somewhat behind the row of the Meibomian openings.

[1] Myrtle-leaf-shaped, *μυρσινοειδής*. — Paulus Aegineta.

[2] Hence the name *ἀναρραφή*, given by the Greek writers to the whole operation, which has seemingly given rise to the widely prevalent misconception that the ancient writers were often content with the excision of a strip of skin and the closure of the wound by sutures. As a fact, the *ἀναρραφή* proper was sometimes omitted, but never the *ὑποτομή*, in the operation on the upper eyelid.

3 *cf.* Roser, *Archiv f. physiologische Heilkunde*, XII, 511.

4 Aetius; Paulus Aegineta.

5 Celsus; Aetius.

6 Paulus Aegineta.

7 Aetius; Paulus Aegineta.

The results obtained by the operation, as thus developed, were generally most excellent. The deep incision through the conjunctiva and tarsus gaped sufficiently to permit the cilia-bearing lid-margin to be turned well forward and fixed in its new position without undue tension on the sutures: not infrequently the conjunctiva retracted strongly when divided, so as to uncover the tarsal tissue, along the borders of the line of incision, to the width of a millimetre or even more. The under-incision healed kindly and without inflammatory complication, sometimes in the course of a few days and without the interposition of much new tissue, in other cases more slowly and with more abundant formation of new connective tissue which, however, showed little tendency to contract in width so as to reproduce the previous incurvation: even in cases of typical distichiasis, the row of abnormally directed cilia, relieved from tension on the side of the incised conjunctiva, generally fell into line with the normal cilia in the course of a few days. The previously thinned or rounded lid-margin became re-established in its original width, with a sharp and well-defined posterior angle, and with the row of openings of the Meibomian glands presenting in their normal situation. The cilia, whenever they had been spared by the previous disease, and had not been sacrificed in earlier attempts at surgical treatment, took on an improved and often very luxuriant growth, the tarso-orbital fold was well-preserved, and, with the exception of an inconspicuous and smooth cicatrix on the conjunctival aspect of the lid, there remained scarcely any trace of the very radical operation which had been performed. The effect of the under-incision in increasing the height of the tarsus upon its conjunctiva aspect was quite conspicuous, as appeared most strikingly on comparing the condition of the two upper eyelids in cases in which but one had been subjected to operation, and this not only when examined within a few weeks, but also after the lapse of two or three years.[1]

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1 This was very strikingly shown in a case of old contraction of the tarsus, following trachoma in which the whole conjunctival sack had been deeply stained by nitrate of silver. A comparison of the two upper eyelids, a year and a half after the operation, showed, in the operated eye, an increase in the height of the tarsus equal to fully two millimetres; the line of the under-incision was marked by a band of unstained tissue, of a width of fully three millimetres, which presented a smooth and even surface scarcely to be distinguished from that of the normal tarsal conjunctiva.

During the ten years which have elapsed since the publication of my first notice of this operation in its essentially perfected form,[1] I have employed it, to the exclusion, almost, of other methods, in the treatment of entropium of the upper eye-lid,[2] and always with enhanced appreciation of its value. Such further modifications as I have learned to make in the procedure have been confined to certain details of operative technique, and to the means adopted to promote the requisite eversion of the lid-margin without needless sacrifice of any part of the lid-integument.

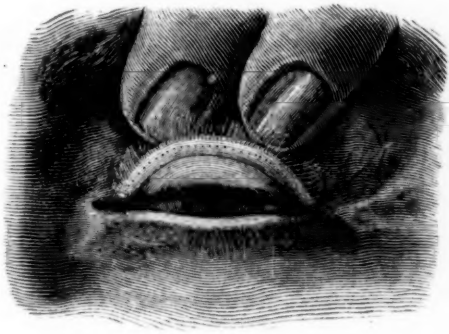

Fig. 24.

In executing the under-incision, I have dispensed with clamps of all kinds, and have found it sufficient to evert the eyelid and to hold it in position by means of the fingers, with the interposition, when necessary, of a scrap of linen or cotton rag.[3] See Fig. 24.

The cutting instrument which has been found most convenient and effective for incising the tarsal tissue, is a full-bellied scalpel

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1 *Transactions of the Fifth International Ophthalmological Congress*, New York, 1876.

2 Almost the only exceptions have been in cases in which the inversion has been confined to about the temporal third of the lid-margin; in such cases, canthotomy, with union of the cutaneous and conjunctival borders of the cut by sutures, has frequently sufficed to effect an excellent cure.

3 Aetius and Paulus Aegineta direct that a thread be passed through the eyelid to aid in its eversion in cases in which the eyelashes are wanting, an expedient which I have never had occasion to adopt.

of the form shown in Fig. 22. It shouldbe of hard temper, and very sharp. The under-incision should, in nearly all cases, be carried nearly or quite through the tarsal tissue, taking especial care to spare the orbicularis muscle, and it should extend, as a rule, from the temporal to the nasal extremity of the tarsus.[1]

The excision of the narrow strip of integument may be made, (1) by putting the eyelid tightly on the stretch by means of the fingers, and then marking out the limits of the portion to be excised with the knife used in making the under-incision,[2] (2) by

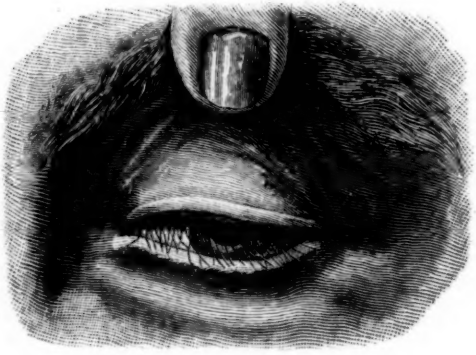

FIG. 25.

transfixing the skin by means of v. Graefe's cataract-knife, and cutting forward, or (3) by pinching up a narrow fold of skin by

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[1] *βαθυτέρα δὲ ἔστω ἡ ὑποτομή· . . . καὶ ἀπὸ τῶν περάτων τοῦ ταρσοῦ εἰς τὰ πέρατα διδόσθω.* — Aetius.

καὶ δώσομεν τὴν ὑποτομὴν ἐσωτέρω τῶν νυττουσῶν κατὰ τοῦ ταρσοῦ, ἀπὸ τοῦ μεγάλου κανθοῦ διήκουσαν ἄχρι τοῦ μικροῦ. — Paulus Aegineta.

εἰ δὲ ἐν μέρει τινὶ μόνον τοῦ βλεφάρου ἀπὸ τῶν τριχῶν γίνοιτο νυγμός, κατ' ἐκεῖνο καὶ μόνον ποιεῖσθαι προσήκει τὴν χειρουργίαν. — Paulus Aegineta.

Whether, in any particular case, a shorter under-incision is permissible, will depend mainly upon the extent of the inverted portion of the lid-margin, as shown by the faulty direction of the openings of the Meibomian glands, and upon the completeness of the relaxation afforded by a tentative shorter incision. If the short incision is found to be in any degree inadequate it should be immediately extended, in either direction or both, until full relaxation of the parts is secured. In cases in which a preliminary canthotomy has been performed the under-incision should generally stop somewhat short of the temporal extremity of the tarsus.

2 Celsus; Aetius; Paulus Aegineta.

the aid of appropriate forceps,[1] and cutting it off with the scalpel[2] or with scissors.[3] In any case, the excised portion should be limited strictly to the integument, leaving the superficial fascia intact. The size, shape and position of the largest piece of skin which I believe it ever to be advisable to excise are shown in Fig. 25.

If sutures are used to close the gap in the skin, and at the same time to elevate and evert the lid margin, it may be sufficient simply to unite the lips of the wound,[4] or it may be preferable to insert them more deeply, in the manner shown in FIG. 23. In the latter case, the threads should be tied quite loosely, so as moderately to evert the lid-margin but not to constrict the included tissues.

After the insertion of the sutures, in cases in which the eyelashes are sufficiently preserved, it is often of advantage to turn them upward, across the line of the closed wound, and to fix them in this position by means of collodion. The sutures may then be removed, in some cases as soon as the collodion has become thoroughly dried, in other cases preferably on the next day, or sometimes a day or two later. If the deep sutures have been used, it is not well, as a rule, to leave them *in situ* longer than twenty-four hours, lest suppuration be set up in their tracks, with possible formation of small abscesses. After the removal of the sutures, the newly-formed cicatrix should generally be supported for a few days by means of collodion, which may be strengthened, in case of need, by the admixture of a few fibres of cotton.

In a large proportion of cases, I have found it better to abstain both from the excision of any portion of skin, and from the employment of sutures in any manner. Here collodion renders most effective service, and it should be of the old fashioned contractile sort; if it has become thickened by evaporation, it should

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[1] *βλεφαροκατόχῳ μυδίῳ.* — Paulus Aegineta.

[2] Ibid.

[3] Albucasis; Jesu Hali—cited from F. Adams, commentary on Paulus Aegineta, VI, VIII; Sydenham Soc'y Edition.

[4] Celsus; Aetius.

be thinned by the addition of fresh ether before using. Probably the best manner of applying it, in the greater number of cases, is by simply penciling the skin, to the width of three or four millimetres, along a line parallel to the row of cilia, renewing the application from day to day as may be necessary to maintain a proper degree of eversion. Should the contraction of the collodion in this position prove insufficient to evert the lid-margin perfectly and uniformly, the entire row of eyelashes, or such of them as remain in any degree inverted, may be turned up against the front of the eyelid and fixed there by a little more collodion. The conjoined leverage of a considerable number of eyelashes is thus effectively utilized to maintain the necessary eversion until the parts have become fixed in their new relations.

In certain cases the under-incision proves sufficient by itself,[1] so that even the pencilling of the skin with collodion may be omitted.

The effect of the under incision, when well placed and of suitable depth and length, is both to improve the curvature of the tarsus as a whole, and to relieve the previously inverted lid-margin, together with the cilia, from the abnormal traction exerted by the contracted conjunctiva and tarsal tissue. The former of these indications is often best fulfilled when the under-incision is placed several millimetres behind the line of the openings of the Meibomian glands, but, in that position, it may prove not altogether adequate to the perfect relaxation of the marginal tissues. For this reason, it is better, in certain cases of extreme incurvation, to follow the suggestion of Aetius, and to make two under-incisions, the one quite near to the lid-margin, or within a millimetre, or less, of the openings of the Meibomian glands, the other further back, at a distance of about two millimetres from the first. A serious fault of position, or insufficiency in extent or depth, of the under incision, may occasionally result in a material impairment of the result of the operation, and in such a case, we may be tempted to try to increase the primary effect by the excision of a broad strip of skin, or perhaps of skin together with the underlying muscle. The better plan, however,

1 *cf.* Celsus.

is to make a second under-incision, and then to pencil the skin with collodion, or to plaster the eyelashes against the front of the eyelid. This secondary under-incision may be made at any time during the progress of the primary cicatrization, or at any later period whenever the need of it shall have become apparent. It is not infrequently advisable to operate for entropium before the trachomatous process has fully run its course, in order promptly to relieve the cornea of the contact of the inverted cilia, thus possibly saving a seriously imperiled eye, and at the same time putting an end to the persistent irritation which militates strongly against the successful treatment of the trachoma. By operating thus early, we incur, however, the risk of a recurrence of some degree of entropium through further cicatricial contraction of the tarsus, and so, may ultimately have to perform a supplementary operation. In such a case, I have found that a new under-incision, conjoined with the use of collodion in one of the ways already noticed, best fulfills all the indications; it may be performed at any time after the issue of the first operation has fully declared itself.

The under-incision, either by itself or conjoined with the use of collodion, affords also the best resource for supplementing the imperfect results which are often met with after other operations, such as the operation of Arlt, grooving the front of the tarsus, splitting the eyelid and abscising a marginal strip of tissue containing the cilia, excision or cauterization of the hair-follicles, etc. In such cases, after making the under-incision, I have generally abstained from excising any portion of the integument, and also from the use of sutures in any manner, and have relied mainly upon collodion to effect the required eversion of the lid-margin.

Canthotomy, conjoined as a rule with division of the external canthal ligament and union of the cutaneous and mucous borders of the cut by sutures, has been performed in many cases of aggravated blepharospasm, and generally in cases of marked contraction of the palpebral fissure. When the entropium has been limited to about the temporal third of the eyelid, the canthotomy has often proved sufficient for its complete correction, but in the greater number of cases it has been found ne-

cessary to supplement it by an under-incision, made after the full effect of the canthotomy has become manifest. In such cases the under-incision should generally begin near the nasal extremity of the tarsus, and should be extended, in the temporal direction, a few millimetres beyond the extreme limit of the still incurved portion of the lid-margin

A few special points incidental to the operation remain to be noticed.

Rather free bleeding from the under-incision has been occasionally observed, either at the time of the operation or some hours later; this has always been readily controlled by the use of iced compresses.

Granulomata not infrequently appear in the tarsal wound, and may have to be removed by scraping or by scissors.

In perhaps one-third of the cases, and chiefly when the healing of the under-incision has been somewhat protracted, the newly-formed scar-tissue has shown a tendency to contract in a longitudinal direction, giving rise to puckering of the lid-margin with more or less excessive eversion at about the middle of the tarsal border. If this is but moderate in degree, it may be neglected, as the slight disfigurement usually disappears in the course of a few months, but if the eversion is so great as materially to impair the general excellence of the result, it is better to correct it at once by making one, two or three deep incisions, through the conjunctiva and tarsus, at right angles to and crossing the line of the original under-incision. This may be done as soon as the distortion of the lid-margin has become manifest, and generally before the cicatrization of the under-incision is quite complete. These vertical incisions gape freely, and become quickly filled with new tissue; when made at the period suggested they do not materially delay the cure, and they often prove of very great utility by increasing the area and improving the configuration of the tarsus.

The operation *ἀναρραφὴ τοῦ ἄνω βλεφάρου*—*sutura palpebræ superioris*—appears to have been of gradual development. Traces of such an operation appear already in the Hippocratic writings[1], but the description is so meagre as to

[1] *Περὶ διαίτης ὀξέων, β.*

leave room for much conjecture as to its precise character. It would appear, however, to have been at first a sewing upward—*ἀναρραφή*—of the lid-margin, with strangulation of a bit of skin, but without the formal excision of any portion of the lid-integument. The operation was practically complete in the time of Celsus, (1st Century, A. D.), although Aetius (6th century) calls it by the name of Leonidas, who appears to have lived in the 3d century; Paulus Aegineta (7th century) writes of it as of an old and well-established method. An adequate estimate of the character of the operation is hardly to be obtained from either Celsus or Paulus Aegineta, although their descriptions fit well into that of Aetius, which is, so far as concerns the *ὑποτομή*, by far the most complete and in the main very clear. Unfortunately, the text of Aetius has never been critically edited, and but half of his extensive treatise has ever been printed[1]; the Latin versions of Montano[2] and Cornaro[3] leave much to be desired as regards accuracy. The Arabic writers on medicine, so far as their works are accessible in the Latin versions, appear to have done little more than to copy from the earlier Greek and Roman authors. Fragmentary and often very inaccurate notices of the ancient teachings are to be found scattered here and there through the systematic works on the eye, but generally as mere matters of history. The name *ἀναρραφή*, which was doubtless accurately descriptive of the Hippocratic and post-Hippocratic operation, had ceased to be appropriate even in the time of Celsus, when the suture of the integument had been supplemented by the more important under-incision—*ὑποτομή*, yet the name is retained in the latest descriptions which have come down to us in the Greek language, and minute directions are given regarding even the minor details of the *ἀναρραφή* proper, to the comparative neglect of the *ὑποτομή*.

Both the *ἀναρραφή* and the *ὑποτομή* occur in more or less modified forms in several of the modern operations for entro-

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1 Venetiis, 1534.
2 Basiliae, 1535.
3 Lugduni, 1549.

pium and trichiasis. In the well-known Crampton-Adams-Guthrie operation (1806, 1814, 1823), both parts of the ancient procedure are reproduced, although with alterations and additions which have gone very far to spoil it. The *tarsotomia horizontalis* of v. Ammon. (1833) and the modified *tarsotomia* of Roser (1853) combine the effect of the *ἀναρραφή* and the *ὑποτομή*, but at the cost of needless impairment of the nutrition of the severed lid-margin. The operation of G. Jæsche, both in its original form (1844) and as described by E. Jæsche (1873), is essentially the *tarsotomia* as modified by Roser. Burow, Sr., (1873) has approached nearest to the ancient procedure, in the manner of conducting the incisions, but he has directed the under-incision to be made unnecessarily deep—"*bis auf die Cutis*"—, and by following this, in most cases, by the excision of a fold of the integument he has accomplished a result which is scarcely to be distinguished from that attained by Roser and Jæsche. The celebrated operation of Arlt (1850) is so varied from its prototype in G. Jæsche's procedure as to substitute the splitting of the lid-margin, as in Flarer's operation, for the incision upon the conjunctival aspect of the upper lid.

The procedure of the ancients may be briefly summed up as consisting in (1) the under-incision—*ὑποτομή*—, a pretty deep incision made in the previously everted upper lid, parallel to its free border, and, as I believe, behind the row of openings of the Meibomian glands,and (2) the *ἀναρραφή* proper, which consisted in the removal of a crescent-shaped portion of the lid-integument, with closure of the wound by sutures which were often made more effective in everting the lid-margin by plastering the ends of the threads under the eyebrow or to the forehead. The sufficiency of the *ὑποτομή*, in cases of moderate inversion, without having recourse to the *ἀναρραφή* proper, is expressly recognized by Celsus, who is correctly cited upon this point by Himly; Burow also has repeated the same observation. The single criticism to which the ancient operation has appeared to me to be open is in regard to the *ἀναρραφή* proper, in which the tendency of the teaching of the three authors cited would seem to be to the excision of too broad a strip of integument. The plan of inserting

the sutures as indicated in Figure 23 has proved in my hands at least as efficiousness in promoting the eversion of the lid-margin as the more complicated and cumbersome expedient of plastering the ends of the threads to the forehead, but even this I have come gradually to abandon in favor of the use of collodion, as already described.

Inasmuch as a part of the literature on the subject of this operation is not easily accessible, I have thought it worth the while to bring together the three passages from the ancient authors to which I have referred in this paper. For access to the only copy of Aetius which I have been able to find in the original Greek, I desire to acknowledge my obligations to the Library of the Surgeon-General, U. S. A., at Washington. For indispensable assistance, most kindly rendered in recovering an intelligible text from the unedited Aldine edition of this author, I am indebted to the critical scholarship of my friend, Professor John Williams White, of Harvard University.

Ea vero curatio quae palpebrae laxioris ab omnibus frequentatur, nihil habet dubii. Siquidem oportet contecto oculo mediam palpebrae cutem, sive ea superior, sive inferior est, apprehendere digitis, ac sic levare: tum considerare quantulo detracto futurum sit, ut naturaliter se habeat. Siquidem hic quoque duo pericula circumstant: si nimium fuerit excisum, ne contegi oculus non possit; si parum, ne nihil actum sit, et frustra sectus aliquis sit. Qua deinde incidendum videbitur, per duas lineas atramento notandum est sic, ut inter oram, quae pilos continet, et propiorem ei lineam, aliquid relinquatur, quod apprehendere acus postea possit. His constitutis, scalpellus adhibendus est: et si superior palpebra est, ante; si inferior, postea propius ipsis pilis incidendum: initiumque faciendum in sinistro oculo, ab eo angulo, qui tempori; in dextro,

ab eo qui naribus propior est: idque, quod inter duas lineas est, excidendum. Deinde orae vulneris inter se simplici sutura committendae, operiendusque oculus est. Si parum palpebra descendet, laxanda sutura; si nimium, aut adstringenda, aut etiam rursus tenuis habenula ab ulteriore ora excidenda: ubi secta est, aliae suturae adjiciendae, quae supra tres esse non debent. Praeter haec in superiore palpebra sub pilis ipsis incidenda linea est, ut ab inferiore parte diducti pili sursum spectent: idque, si levis inclinatio est, etiam solum satis tuetur. Inferior palpebra eo non eget. His factis, spongia ex aqua frigida expressa superdeliganda est: postero die glutinans emplastrum injiciendum: quarto suturae tollendae, et collyrio, quod inflammationes reprimat, super inunguendum.

Nonnumquam autem, nimium sub hac curatione excisa cute, evenit, ut oculus non contegatur: idque interdum etiam alia de causa fit. Λαγωφθάλμους Graeci appellant. In quo si nimium palpebrae deest, nulla id restituere curatio potest: si exiguum, mederi licet. Paulum infra supercilium cutis incidenda est lunata figura, cornibus ejus deorsum spectantibus. Altitudo esse plagae usque ad cartilaginem debet, ipsa illa nihil laesa: nam, si ea incisa est, palpebra concidit, neque attolli postea potest. Cute igitur tantum diducta fit, ut paulum [in] ima [oculi] ora descendat; hiante scilicet super plaga; in quam linamentum conjiciendum est, quod et conjungi diductam cutem prohibeat, et in medio carunculam citet: quae ubi eum locum implevit, postea recte oculus operitur.

Celsus, *De med.*, Lib. VII., cap. vii. 8, 9, ed. Daremberg, Lipsiae, 1859.

Περὶ ἀναρραφῆς καὶ καταρραφῆς βλεφάρων, Λεωνίδους.

Πρὸς τὴν ἀναρραφὴν καθέδριον ὁ πάσχων σχηματιζέσθω πρὸς τοῖς ἀριστεροῖς μέρεσι τοῦ ἐνεργοῦντος, ταπεινότερος αὐτοῦ, πρὸς αὐγὴν λαμπράν. ἔστωσαν δὲ καὶ οἱ ὑπηρέται εὐπαίδευτοι δύο παρεστῶτες, εἷς μὲν ὄπισθεν ἀντιβαίνων, εἷς δὲ ἐκ πλαγίων. ὁ δὲ χειρίζων πρῶτον σημειούσθω κολλυρίῳ ἢ ἐγχαράξεσιν ἐπιπολαίοις τὴν αὐτάρκη τοῦ περιττεύοντος κατὰ τὸ βλέφαρον καὶ ἐρρυτιδωμένου δέρματος ἐκτομήν, ἵνα μήτε πλέον τοῦ δέοντος ἐκτμηθῇ μήτ' ἔλαττον. πλατυτέρου μὲν γὰρ ἐκτμηθέντος, λαγόφθαλμος γίγνεται ὁ πάσχων· στενοτέρου δὲ ἐκτμηθέντος, πάλιν χαλᾶται τὸ βλέφαρον, καὶ νύττουσιν ὁμοίως αἱ τρίχες. σημειούσθω δὲ καὶ ὁ κατὰ τὴν μεσότητα τοῦ βλεφάρου πρὸς τὸν ταρσὸν τόπος ἐπιπολαίῳ διαιρέσει. μετὰ δὲ τὴν σημείωσιν ἐκστρέψαντες τὸ βλέφαρον διδῶμεν[1] τὴν ὑποτομὴν ἔσωθεν τῶν παρὰ φύσιν τριχῶν, ὥστε αὐτὰς πρὸς τὰς κατὰ φύσιν ἔξω νεῦσαι. ἐνίοτε δὲ κατ' αὐτῶν τῶν παρὰ φύσιν τριχῶν, εἴγε ἐνδοτέρω ᾖ,[2] τάσσομεν τὴν ὑποτομήν, ἵνα ἡ ἐπιγιγνομένη οὐλὴ κωλύσῃ αὐτὰς πάλιν φυῆναι. οὐδὲν δὲ κωλύει καὶ δύο ὑποτομὰς διδόναι, μίαν μὲν ἐνδοτέρω τῶν παρὰ φύσιν τριχῶν, ἵνα ἀνάκλασις γένηται τοῦ ταρσοῦ, ἑτέραν δὲ κατ' αὐτῶν τῶν παρὰ φύσιν τριχῶν. βαθυτέρα δὲ ἔστω ἡ ὑποτομή· συνεργεῖ γὰρ τῇ ἀνακλάσει καὶ τῷ κουφισμῷ τοῦ βλεφάρου· καὶ ἀπὸ τῶν περάτων τοῦ ταρσοῦ εἰς τὰ πέρατα διδόσθω. ἔπειτα πτυγμάτια μικρὰ δεδιπλωμένα τρίγωνα τῷ σχήματι τασσέσθω, ἓν μὲν παρὰ τῷ μεγάλῳ κανθῷ, καὶ ἕτερον πλησίον τοῦ μικροῦ. κατὰ

[1] διδόαμεν [2] ᾖ

δὲ τούτων τῶν πτυγματίων ὁ ἔξωθέν τε καὶ ὀπίσω ἑστὼς ὑπηρέτης ἐρειδέτω τὰς κορυφὰς τῶν μέγα δακτύλων, καὶ ὑπὸ μίαν ὁρμὴν διατεινέτω τὸ βλέφαρον, ἐρείδων τὸν δάκτυλον ὑπὸ τὴν ὀφρῦν, ἵνα ἰσότονος γένηται ἡ τοῦ βλεφάρου τάσις. σημεῖον δέ σοι ἔστω τῆς καλλίστης τάσεως τοῦ βλεφάρου, ὅταν τὸ μέσον σημεῖον φυλάξῃ τὸν ἴδιον τόπον, τουτέστι κατὰ τὴν μέσην εὐρεθῇ. μετὰ τὴν διάτασιν δέ, πρῶτον δοτέον τὴν πλαγίαν καὶ ὀβελιαίαν κάτω διαίρεσιν ἐπιπολαίαν, ἵνα μὴ τὸ ἐπιρρέον ἐκ τῆς ἄνωθεν αἷμα παρεμποδὼν γένηται τῇ χειρουργίᾳ. ἔστω δὲ ἡ τομὴ συνεγγίζουσα ταῖς βλεφαρίσιν. ἔπειτα δοτέον τὴν ἄνω μηνοειδῆ διαίρεσιν. ἀρχέσθω δὲ καὶ αὐτὴ κάτωθεν ἐκ τοῦ πρὸς τὸν μέγαν κανθὸν τόπου, καὶ ἀναφερομένη ἐπὶ τὸ σημεῖον πάλιν νεμέτω κάτω περὶ τὸν μικρὸν κανθόν. ἔστω δὲ καὶ αὐτὴ ἐπιπολαιοτέρα, ἵνα μὴ μυότρωτος γένηται ὁ πάσχων. εἶτα ἐκ πλαγίων ἑστὼς ὑπηρέτης ἀνατεινέτω τὸ βλέφαρον. ἔπειτα ἄγκιστρον καταπειρέσθω εἰς τὴν ἀρχὴν τοῦ περικεχαραγμένου τενιδίου, ἐπὶ μὲν τοῦ ἀριστεροῦ ὀφθαλμοῦ πρὸς τῷ μικρῷ κανθῷ, ἐπὶ δὲ τοῦ δεξιοῦ, πρὸς τῷ μεγάλῳ. ἀναταθέντος δὲ τοῦ ἀγκίστρου τῇ ἀριστερᾷ χειρί, ὑποδερέσθω τὸ τενίδιον τῷ ἀναρραφικῷ[1] σμιλίῳ, προσέχοντες ἵνα μὴ ἐπιπολὺ βαθυνομένης τῆς ὑποδορᾶς μυότρωτοι γένωνται καὶ ἀνίατον ἔχωσι τὸ χάλασμα τοῦ βλεφάρου. μετὰ δὲ τὴν τοῦ δέρματος ἐκτομήν, ἐπὶ τὴν ἀναρραφὴν ἐλθετέον· διδόσθω δὲ πρώτη ῥαφὴ ἡ μέση· ἔπειτα ἑκατέρωθεν ἄλλαι δύο, ὡς εἶναι τὰς πάσας ῥαφὰς πέντε. μετὰ δὲ τὴν ἀναρραφήν, ἀνατείνας τὸ βλέφαρον διὰ τὰ τραύματα, συμμέτρῳ σπληνίῳ ἐχεκόλλῳ καταλαβοῦ τὰ ῥάμματα ὑπὸ τὴν ὀφρῦν. κατὰ δὲ τῶν διαιρέσεων σπληνάρια μικρὰ κολλητικῆς καὶ ἀφλεγμάντου δυνάμεως ἐπιτιθέναι. ἔπειτα

[1] ἀναρριφικῷ.

ἔριον ὠοβραχὲς καθ' ὅλον τὸν ὀφθαλμόν, καὶ ἐπιδέσμει. ἐπειδὴ δὲ ἐπιτεῖνον καὶ δριμὺ καὶ ἁλμυρὸν φερόμενον ῥεῦμα ἀποβάλλει τὰς κατὰ φύσιν τρίχας καὶ σκληρὸν τὸν ταρσὸν ἀποτελεῖ, ταῖς δὲ παρὰ[1] φύσιν ὑποπεφυκυίαις θριξὶ καὶ αὔξησιν παρέχει, δυσχερής τε ἐπὶ τούτων ἡ ἐκστροφὴ τοῦ βλεφάρου γίγνεται, προσήκει βελόνην ῥάμμα στερεὸν ἔχουσαν καταπείρειν τῷ μέσῳ τοῦ ταρσοῦ καὶ ἀνέλκειν ἐπὶ τὸ ἄνω τὸ ῥάμμα, καὶ οὕτω τῇ μήλῃ ἐκστρέφειν τὸ βλέφαρον κατὰ τὸ ἔθος· καὶ διδόναι τὴν ὑποτομὴν ὡς προείρηται.

Περὶ καταρραφῆς.

Τοῦ δὲ κάτω βλεφάρου τριχιῶντος, καταρραφὴ δοκιμάζεται. πρότερον δὲ κἀπὶ τούτων σημειούσθω ἡ[2] αὐτάρκης τοῦ κεχαλασμένου[3] περιττοῦ δέρματος ἐκτομή. κἀνταῦθα γὰρ πλατυτέρου ἐκτμηθέντος τενιδίου, ἐκτρόπιον γίγνεται, στενοτέρου δέ, ἀνωφελὴς ἐστιν ἡ χειρουργία. μετὰ δὲ τὴν σημείωσιν τὰ πτύγματα ὡς προείρηται κατὰ τῶν κανθῶν τασσέσθω, καὶ περιτεινέσθω το βλέφαρον. ἔπειτα πρὸς τῷ μήλῳ ἐρείδων τὸν δάκτυλον ὑπηρέτης καθελκέτω κάτω. διδόσθω δὲ πρώτη διαίρεσις ἡ μηνοειδὴς λεγομένη ἡ κάτω. ἔπειτα ἡ ὀβελιαία καὶ πλαγία λεγομένη ἡ περὶ τὸν ταρσόν. ὑποδέρειν δὲ ὡς προείρηται καὶ ῥάπτειν· καὶ τὰ ἀκόλουθα ποιεῖν. μόνῃ δὲ τῇ καταρραφῇ ἀρκούμεθα ἐπὶ τοῦ κάτω βλεφάρου, παραιτούμενοι τὴν ὑποτομήν, ἵνα μὴ ἐκτροπὴ τοῦ βλεφάρου γένηται.

Aetius, Lib. VII., cap. lxxi., lxxii., ed. Ald. Venetiis, 1534.

[1] κατὰ [2] εἰ [3] χαλασμένου

Περὶ ἀναρραφῆς καὶ ἑτέρων τρόπων ἐπὶ τριχιώντων.

. . . . . .

Καθέδριον τοίνυν σχηματίσαντες τὸν κάμνοντα, ἤτοι ἐμπρὸς ἡμῶν, ἢ ἐξ εὐωνύμων, ἐκστρέψομεν τὸ ἄνω βλέφαρον, εἰ μὲν μακρὰς ἔχοι τὰς τρίχας, αὐτῶν ἐκείνων τῷ λιχανῷ καὶ μεγάλῳ δακτύλῳ τῆς ἀριστερᾶς ἐπιλαβόμενοι χειρός, εἰ δὲ πάνυ βραχείας, βελόνην ἔχουσαν ῥάμμα διὰ μέσου τοῦ ταρσοῦ ἔσωθεν ἐπὶ τὰ ἔξω διαπείραντες· εἶτα διὰ τοῦ ῥάμματος ἀνατείναντες τῇ ἀριστερᾷ τὸ βλέφαρον, τῇ δεξιᾷ τῷ πυρῆνι τῆς σμίλης ὄπισθεν τοῦ ῥάμματος αὐτὸ κολπώσαντες ἐκστρέψομεν, καὶ δώσομεν τὴν ὑποτομὴν ἐσωτέρω τῶν νυττουσῶν κατὰ τοῦ ταρσοῦ, ἀπὸ τοῦ μεγάλου κανθοῦ διήκουσαν ἄχρι τοῦ μικροῦ. τὸ δὲ ῥάμμα ὑπολαβόντες μετὰ τὴν ὑποτομὴν καὶ τῷ ἀντίχειρι τῆς ἀριστερᾶς χειρὸς ὑποβαλόντες μικρόν τι πτυγμάτιον, ἀνατείνομεν τὴν ὀφρῦν· καὶ ἕτερα δὲ μικρὰ πτυγμάτια τάξαντες ἐν ἄκροις τοῖς κανθοῖς, κελεύσομεν τῷ ὄπισθεν ἑστῶτι ὑπηρέτῃ δι' αὐτῶν διατείνειν τὸ βλέφαρον· καὶ τότε δι' ἀναρραφικοῦ σμιλίου δώσομεν πρῶτον τὴν ὀβελιαίαν καλουμένην διαίρεσιν, μικρόν ἀνωτέρω τῶν κατὰ φύσιν τριχῶν, ἀπὸ κανθοῦ διήκουσαν ἐπὶ κανθόν, βάθος δὲ ὡς μόνον τὸ δέρμα διαιρεθῆναι. καὶ μετ' αὐτὴν τὴν μηνοειδῆ παράσχωμεν, ἀρχόμενοι μὲν ἔνθεν καὶ ἡ ὀβελιαία ἤρξατο, ἐπὶ τοσοῦτον δὲ ὕψος φερόμενοι ὡς ὅλον τὸ περιττὸν περιγραφῆναι δέρμα, καὶ τελευτῶντες ὁμοίως ἔνθα κἀκείνη· εἶτα τοῦ περιγραφέντος ἐκ τῶν δύο διαιρέσεων δέρματος μυρσινοειδοῦς τυγχάνοντος, τὴν πρὸς τῇ δεξιᾷ ἡμῶν ἀγκίστρῳ πείραντες γωνίαν, ὅλον τοῦτο τὸ δερμάτιον ἀποδείρομεν. εἶτα τοὺς μώλωπας ἀποσπογγίσαντες, τρισὶν ἢ τέσσαρσιν ῥαφαῖς τὰ χείλη τοῦ τραύματος συνάγομεν, ἀπὸ τῆς μέσης ἀρχόμενοι, καταπείραντες δὲ τὴν βελόνην ἐν αὐτῇ τῇ ὑποτομῇ· τὸ δὲ ῥάμμα ἐξ ἐρίου ἔστω. καὶ

κόψαντες τὸ περιττὸν ῥάμμα μὴ πλησίον τῶν ῥαφῶν, ἀλλ' ὥστε περιττεύειν ὡς τριῶν δακτύλων αὐτοῖς μῆκος, τὰ περιττὰ διανατείναντες κατὰ τὸ μέτωπον, ἐμπλάστρῳ τινὶ τῶν ἐχεκόλλων κολλήσωμεν· τὰς δὲ τοῦ βλεφάρου τρίχας ἀκμῇ βελόνης ἀπὸ τῶν ῥαφῶν ἐλευθερώσωμεν.

Οὗτος μὲν οὖν ὁ τρόπος τῆς χειρουργίας κοινός τε καὶ ἀσφαλής. τινὲς δὲ φεύγουσι τὴν ἀποδοράν· δι' ὃ μετὰ τὴν ὑποτομὴν βλεφαροκατόχῳ μυδίῳ, τοῦτ' ἔστι πρὸς τὴν περιφέρειαν τοῦ βλεφάρου ἐσχηματισμένῳ ἀνατείναντες τὸ περιττὸν δέρμα, σμιλίῳ ἀποκόπτουσι, καὶ τὰς ῥαφάς, ὡς ἔφαμεν, ἐπιφέρουσιν. εἰ δὲ ἐν μέρει τινὶ μόνον τοῦ βλεφάρου ἀπὸ τῶν τριχῶν γίνοιτο νυγμός, κατ' ἐκεῖνο καὶ μόνον ποιεῖσθαι προσήκει τὴν χειρουργίαν. ἔπειτα πτυγμάτια βρέξαντες ἐν ὀξυκράτῳ καὶ ἐπιθέντες ἐπιδήσομεν, ἐπιβρέχοντες αὐτῷ τῷ ὀξυκράτῳ ὑδαρεῖ ἄχρι τῆς τρίτης, καθ' ἣν ἐπιλύσομεν· καὶ κόψαντες τὰ περιττὰ τῶν ῥαμμάτων περιχρίσομεν ἢ κρόκῳ ἢ γλαυκίῳ τὰ βλέφαρα, ἤ τινι τῶν ἀφλεγμάντων κολλυρίων, οἷον κροκινῷ ἢ διαρρόδῳ τινί. εἰ δὲ φλεγμαίνοιεν αἱ ῥαφαί, καὶ ἐμπλάστριόν τι τῶν ἁπαλῶν αὐταῖς ἐπιθήσομεν, καὶ ὠογάλακτι ἐγχύτῳ τὸν ὀφθαλμὸν παραμυθησόμεθα· χαυνωθείσας δὲ τὰς ῥαφὰς κόψαντες διασύρομεν.

Οἶδα δέ τινα τὴν μὲν ἀποδορὰν τοῦ βλεφάρου ποιούμενον, ὡς εἴρηται, ῥαφαῖς δὲ μὴ χρώμενον, ἀλλὰ δι' ἀπουλωτικῶν φαρμάκων ἀποθεραπεύοντα. συνουλουμένου γὰρ τοῦ τραύματος, τὸ βλέφαρον κατὰ μέρος ἀνατεινόμενον τὰς τρίχας ἐκτὸς ἠνάγκαζε νεύειν. ὥσπερ οὖν ἕτερός τις οὐδὲ τῇ ἀποδορᾷ τοῦ βλεφάρου, οὐδὲ ταῖς ἐκτὸς δύο χρώμενος διαιρέσεσιν· ἀλλὰ τὴν ὑποτομὴν μόνον διδοὺς ἀνέτεινε τοῖς δακτύλοις ἢ δι' ἀγκίστρου τὴν ῥυτίδα τοῦ βλεφάρου, καὶ δυσὶ καλαμίοις ἢ πεταλίοις τισίν, ἴσον ἔχουσι τοῦ βλεφάρου μῆκος, τὸ δὲ πλάτος

ὅσον στενοῦ φλεβοτόμου, τὸ περιττὸν ὅλον δέρμα μέσον λαβών, διέσφιγγε δεσμῶν αὐτὰ καθ' ἑκάτερα τὰ πέρατα, καὶ οὕτως ὅλον τὸ ὄπισθεν δέρμα μὴ τρεφόμενον, καὶ διὰ τοῦτο νεκρούμενον, εἶσω δεκάτης ἢ πεντεκαιδεκάτης τὸ πλεῖστον ἡμέρας σὺν τοῖς καλαμίοις ἢ πεταλίοις ἐξέπιπτεν, ὡς μήτε σχεδὸν οὐλήν τινα φαίνεσθαι.

Περὶ λαγοφθάλμων.

Λαγοφθάλμους καλοῦσι τοὺς τὸ ἄνω βλέφαρον ἀνεσπασμένον ἔχοντας. τοῦτο δὲ γίνεται τὸ πάθος ἢ φυσικῶς, ἢ ἐξ οὐλῆς τραύματος· καὶ τούτου ἢ αὐτομάτως, ἢ ὑπὸ ἀναρραφῆς, ἢ καύσεως, ὡς ἀρτίως ἐλέγομεν, ἀφυῶς γεγενημένης. ἐφ' ἧς καὶ μόνον μετρία δύναται γενέσθαι διόρθωσις, πάχος ἱκανὸν ἔχοντος τοῦ βλεφάρου. . . . . .

Περὶ καταρραφῆς καὶ τῆς διὰ φαρμάκου καύσεως.

Ὅσοις τῶν τριχῶν τὸ ἄνω βλέφαρον ὑποπέπτωκε πάθεσι, τοσούτοις καὶ τὸ κάτω· καὶ γὰρ μεῖζον ἑαυτοῦ γινόμενον, ἐκτρέπεται, καὶ φαλάγγωσιν ὑπομένει καὶ διστιχίαν. τῷ οὖν αὐτῷ κἀνταῦθα τῆς ἀναρραφῆς χρηστέον τρόπῳ κατὰ τὴν ἀντίστροφον τάξιν, πρῶτον διδόντα τὴν μηνοειδῆ τομὴν διὰ τὸν ἐκ τοῦ αἵματος παραποδισμόν, εἶτα τὴν ὀβελιαίαν· τὴν δὲ ὑποτομὴν παραιτητέον, ὅτι τῷ συμφύτῳ βάρει τὸ κάτω βλέφαρον ἑτοίμως ἐκτρέπεται. καὶ τὴν ἄλλην δὲ θεραπείαν ὡς ἐπ' ἀναρραφῆς, πλὴν τῶν ῥαμμάτων τὰς ὑπεροχὰς ἐν τῷ μετόπῳ κολλητέον. εἰ δὲ κἀνταῦθα τὴν χειρουργίαν φεύγοντες τὴν διὰ φαρμάκου μᾶλλον αἱροῦνται καῦσιν, καὶ ταύτην ἤδη παρείληφας.

PAULUS AEGINETA, Lib. VI., cap. viii., x., xi., ed. Briau, Paris, 1855.

EDITORIAL.

With this number the AMERICAN JOURNAL OF OPHTHALMOLOGY completes its third volume. The editor and publisher feel that at this occasion they want to thank the medical profession as well for their pecuniary as for their literary support. The subscription list is larger than it was ever expected to become, and is continually increasing, thus giving evidence of the agreeable fact that our work is appreciated and gaining in favor. The literary support has kept pace with it, and we heartily thank our collaborators for having enabled us, more than in the former volumes, to fill our pages with the results of purely original American work.

This was our programm when we started out with what seemed to be a doubtful undertaking. The circulation of our journal both in the United States and abroad is now so large that no article published in its volumes is lost, so to speak, to the scientific world, but on the contrary, is directly brought into that class of medical men to whom any author would most desire to address his work.

The editor and publisher of this journal, in thus conveying their thanks to our patrons, again solicit most earnestly original articles on all subjects connected with ophthalmology, and hope and ask for the continuance of the work of our esteemed collaborators.

The number of the latter has grown so large that it is impossible to have all their names on our cover, much as we would like to have them appear there, since we well know that the success of our journal is largely due to them.

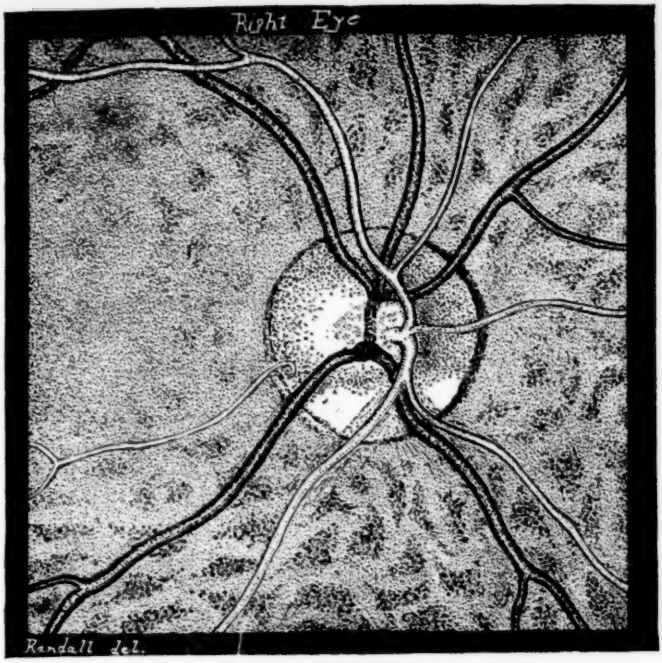
With their continued aid we doubt not but that each volume of the journal will bring more and more original American work, and that the journal will keep on improving in quality and will gain yet more in favor with the medical profession.

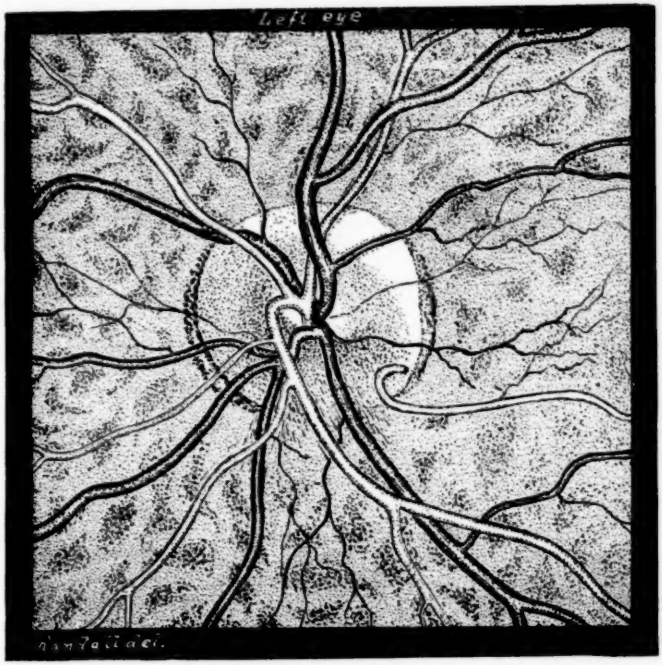
The AMERICAN JOURNAL OF OPHTHALMOLOGY for 1887 will be sent to all present subscribers without further notice. Should any subscriber wish the journal discontinued, he will please give the publisher notice to that effect.

EDITORIAL NOTICE.

The following corrections ought to be made on page 243 of our last number: Second line from below read *types* instead of *lupus*. Fourth line from below read *lupus* instead of *hysus*. Page 336, the ninth line from the top: It should be "under atropia R. V=$^{15}/_{xv}$ w.+.5 D."

We further draw the attention of our readers to the fact that in the review of Dr. Fox's and Mr. Gould's compend on *diseases of the eye*, etc., our statement with regard to *ulcers of the cornea* might cause a wrong idea. We did not mean to state that ulcers of the cornea had been totally omitted; what we meant to state, was that the authors had forgotten to mention them *as a cause of anterior synechia*. We also find that copper in the treatment of trachoma is mentioned, but in our opinion by far not prominently enough.





FIGS. 26 and 27. These figures should have appeared with Dr. B. A. Randall's paper in the November issue of this journal.